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Capital and capacity utilization revisited: A theory for ICT-assisted production systems☆

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Abstract

In this paper we present a framework as how to analyze capital and capacity utilization issues with reference to production processes heavily characterized by the use of ICT. We derive this framework by developing in original way the fund–flow model of Georgescu-Roegen, one of the pioneers of the capital utilization analysis, since this model is able to capture many qualitative aspects of production, above all the issue of the different time profile of use of the production elements.

In the economic literature capital utilization is often equated with capacity utilization. However, if we refer to the neo-classical production analysis, this is true only if there is but one fixed input (capital) and if production is characterized by constant returns of scale. In a different way, we study capital and capacity utilization issues under the hypothesis of increasing returns of scale, particularly significative in ICT-assisted productions. The main contribution of the paper is to show that an important way of varying capital utilization is through the flexibility of a 'machine' to perform some tasks at the same time and the ability of ICT to exploit economically these possibilities. The analysis addresses a partial equilibrium level. Moreover, we show as our framework could be extended to include the case of multi-production with heterogeneous capital.

JEL classification: D24

Keywords: Capital utilization; Capacity utilization; Fund–flows model; Information and communication technologies; Theory of production

☆ The views expressed here are those of the authors and do not necessarily represent those of their institutions.

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1. Introduction

In the last two decades the massive use of information and communication technologies (ICT) has made it possible to perform any production task more accurately, by fine-tuning and improving the utilization of the installed capacity (see Nightingale et al., 2003). The diffusion of ICT has been particularly pervasive in the case of large technical systems such as telecommunications, electric power and railroads, where the production of services is characterized by temporal and spatial variability requiring high flexibility in assigning facilities to user requests.[2] However, the same happened in many manufacturing sectors where one can see a tertiarization and dematerialization of the process of production which tends to meet requirements by means of an integrated series of activities rather than by simply supplying commodities (see Amendola and Gaffard, 1988; p. 12): in these cases the use of "systemic" microelectronics and telecommunications have simplified the management of complex information and the coordination of different activities increasing the levels of utilization of capital, by reducing idle times of the production process, and improving the matching of inputs to output also in the production of goods.

From a theoretical perspective, the relations between capital and capacity utilization and features of the production processes are difficult to analyze and many times they are neglected in the economic literature. This could depend, among other things, on the fact that, according to the traditional analysis of firm, production is viewed as a black box into which inputs are placed and somehow transformed into a quantity of some product. This is so with reference to the neoclassical production function that describes the maximum quantity producible from the vector of inputs, but the same is true in alternative models, wherein production is viewed as a process, with steps or stages[3]: also in this case the level at which an activity is conducted is usually viewed as functionally related to the inputs engaged in that activity (see Neill, 2005).[4] As a result of this approach, many specific features of the production process (as the arrangement of production, the time profile of use of the production elements, economic indivisibility versus technical (in)divisibility aspects) are often completely overlooked.[5] As we shall see in the following, the qualitative aspects of production have very different effects on the level and the way of utilization of capital and capacity.

Moreover, many writers use the terms 'capital utilization' and 'capacity utilization' interchangeably (see Betancourt, 1987). However, capital utilization and capacity utilization are two distinct issues. The first[6] refers to the variation of the level of daily utilization of the machine

[2] In fact in many services available facilities need to become operative exactly when demand emerges.

[3] See Koopmans (1951).

[4] Hence it involves that, "unless fixed coefficients are imposed, it is generally assumed that putting more of any one input into production results in greater output" (Neill, 2005; p. 174).

[5] This is true also with reference to DEA, a recent methodology used extensively to estimate measures of technical efficiency in a range of industries (Cooper et al., 2000). By means of DEA we can simply defines the relative contribution of reference points on the frontier to the estimation of efficient or capacity output for the point under examination. As a result, it is a method for estimating efficiency and capacity utilization, but does not impart any useful information on the features of the production processes (see FAO, 2003).

[6] General summaries of capital utilization are given in Betancourt (1986, 1987). On attempts to consider time and the level of utilization of inputs inside a neoclassical framework see Betancourt and Clague (1981) and Winston (1982). However, there are other definitions of capital utilization. Berndt (1990) defines capital utilization as the ratio of the desired stock of capital (given output and input prices) to the actual stock of capital. Färe et al. (1994) offer the same definition. Hulten (1986, 1990), and Lee (1995) defined capital utilization as the ratio of capital services to the stock of capital.